

Marine Mammal Habitat in Ecuador: Seasonal Abundance and Environmental Distribution

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Abstract- Marine mammals in the Eastern Equatorial Pacific play a vital ecological role toward structuring trophic systems and the distribution commercially valuable prey. However, scientific study of their populations within the waters surrounding Ecuador has been only infrequently conducted and largely neglected over the past decade. Our research including six marine mammal surveys will investigate the distribution of marine mammals inhabiting the oceanic areas between the Ecuadorian mainland and around the Galápagos Islands. Visual observers documented marine mammal sightings while aboard the Ecuadorian Navy's Oceanographic Vessel the (*B/I*) *Orion* last September/October 2008 and April 2009. The range of different species positively identified as well as the large proportion of sightings that could not be identified to species using current survey methodologies, suggests that the diversity and overall marine mammal abundance within Ecuadorian waters may be much higher than previously suspected. Four more surveys covering similar periods of the year will be conducted over the next two years.

Biological patterns in this region are closely tied to physical features. Using satellite data, Palacios (2004) discerned seasonal patterns in the surface concentrations of chlorophyll off the West coast of the Galápagos Islands. Here, upwelling driven productivity (which is initiated by the subsurface derived macronutrients) is enhanced by iron inputs derived from the island platform. The confluence of the Equatorial Undercurrent and Peru Current create an area around the islands where enhanced levels of nutrients are available to the ocean's biology. Palacios' harmonic analysis of ocean color data showed that the seasonal cycle of warming and cooling is associated with the North-South migration of the ITCZ and that ocean color which is

related to surface primary productivity follows these seasonal SST patterns.

Daniel Palacios identified groups of cetacean species that were often sighted in close proximity and described 3 main habitat types around the islands where these groups were found: upwelling modified, stratified, and near-shore. He defined these habitats using composited data from multiple sensors over 9.28 km spatial resolution and averaged over several years to obtain seasonal climatological pictures of cetacean habitat. I will use ocean color from the NASA's Earth observing sensor MODIS (Moderate Resolution Imaging Spectroradiometer) sensor at the same spatial resolution but averaged over days to weeks of time in order to look at more temporally variable processes. Additionally, it may be possible to identify frontal boundaries based on changes in surface chlorophyll-a concentrations. I will compare the spatial and temporal difference between marine mammal sightings and these frontal boundaries.

Oceanographic cruises aboard the *Orion* provide an excellent platform for regular marine mammal surveys to assess the current range of species present in Ecuadorian waters as well as establish a system of surveys that will improve marine resource management in this sensitive ecosystem. These surveys combined with remote sensing data from MODIS, will also provide useful insight into how the distribution of marine mammals is structured in relation to physical environmental features and the underlying biology. Ultimately, we hope to improve the tools and conservation methodologies available to marine resource managers.

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14. ABSTRACT Marine mammals in the Eastern Equatorial Pacific play a vital ecological role toward structuring trophic systems and the distribution commercially valuable prey. However, scientific study of their populations within the waters surrounding Ecuador has been only infrequently conducted and largely neglected over the past decade. Our research including six marine mammal surveys will investigate the distribution of marine mammals inhabiting the oceanic areas between the Ecuadorian mainland and around the Galápagos Islands. Visual observers documented marine mammal sightings while aboard the Ecuadorian Navys Oceanographic Vessel the (B/I) Orion last September/October 2008 and April 2009. The range of different species positively identified as well as the large proportion of sightings that could not be identified to species using current survey methodologies, suggests that the diversity and overall marine mammal abundance within Ecuadorian waters may be much higher than previously suspected. Four more surveys covering similar periods of the year will be conducted over the next two years. Biological patterns in this region are closely tied to physical features. Using satellite data, Palacios (2004) discerned seasonal patterns in the surface concentrations of chlorophyll off the West coast of the Galápagos Islands. Here, upwelling driven productivity (which is initiated by the subsurface derived macronutrients) is enhanced by iron inputs derived from the island platform. The confluence of the Equatorial Undercurrent and Peru Current create an area around the islands where enhanced levels of nutrients are available to the oceans biology. Palacios harmonic analysis of ocean color data showed that the seasonal cycle of warming and cooling is associated with the North-South migration of the ITCZ and that ocean color which is related to surface primary productivity follows these seasonal SST patterns.		

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I. INTRODUCTION

Two marine mammal surveys were conducted aboard the *B/I. Orion* during oceanographic cruises conducted by the Oceanographic Institute of the Ecuadorian Navy (INOCAR)

between mainland Ecuador and the Galápagos Islands in September 2008 and April 2009. Researchers who worked on this project were from Texas A&M University, NOAA's Southeast Fisheries Science Center, and the Ecuadorian Foundation for the Study of Marine Mammals (FEMM).

TABLE 1

Cruise Dates	Area Surveyed	Total Sightings	Nautical Miles Surveyed	Number of Different Species/Groups Sighted
Sep 23 - Oct 10, 2008	80.5W-92.5W 3.3S-1.0W	57	1,032	10

TABLE 2

Cruise Dates	Area Surveyed	Total Sightings	Nautical Miles Surveyed	Number of Different Species/Groups Sighted
Apr 2 - Apr 21 2009	80.5W - 94.5W 3.3S- 1.0N	97	1153	13

Past marine mammal surveys were conducted aboard the *B/I. Orion* in August of 2000 and September of 2001 by researchers from FEMM. During these surveys 5-7 species of marine mammals were identified in Ecuadorian, oceanic waters. Common dolphins and pilot whales were identified as the most abundant and the absence of sperm whales was noted as the most significant departure from previous mammal surveys

II. METHODS

The *B/I. Orion* is an oceanographic vessel 70 m long and maintains average cruising speeds of 7-8 knots. During both cruises the *Orion* followed predetermined North-South tracklines and East-West transit lines and made regular oceanographic measurements at CTD stations. The visual surveys were conducted from the flying bridge during all daylight hours (approximately 0600-1830 hrs) while the ship was underway, except for the thirty minute meal times. While observers were actively searching for mammals, "on effort mode," 2-4 observers used Bushnell 7x50 binoculars to scan from the ship out to the horizon. A starboard observer scanned 90° right of the bow to 0° directly in front of the bow and a port side observer was responsible for 90° left of the bow through 0° in front of the bow. One observer was responsible for keeping notes on survey effort, environmental conditions and sightings.

In September 2008, cruise track and sighting locations were taken from the ship's GPS and log. During the April 2009 cruise, the cruise track and sighting locations were recorded using a handheld Garmin GPS connected to an IBM laptop running data acquisition software written at the Southwest Fisheries Science Center.

Observers confirmed species only when the mammal group came close enough to the ship that observers could clearly see the animals or photograph the animals using a Canon EOS Digital Rebel XS 10.1 megapixel camera and 300-400mm lenses.

III. RESULTS

I. September 2008

In September of 2008 we surveyed approximately 1,032 nautical miles during 124 hours of search effort (these numbers exclude the time while the ship was on a CTD station, observers were at meals or otherwise not on effort and night-time hours). While the survey was on effort there was a total of 57 mammal sightings which included 11 different species or groups of species and an average of 1 sighting for every 18 nautical miles of survey effort. A summary of these sightings appears below in Table 3. A summary of the locations of these sightings can be found in the appendix in Fig. 1-2.

TABLE 3. Sep 23- Oct 10 2009 Cruise Results.

Species	Number of Sightings
Humpback Whale	2
Pilot Whale	3
Orca	1
Common Dolphin	2
Pan-tropical Spotted Dolphin	1
Galapagos Sea Lion	24
Unid Large Whale	3
Unid Baleen Whale	3
Unid Small Whale	8
Unid Dolphin	10

II. April 2009

In April 2009 over 1,000 nautical miles were surveyed during the course of 148 hours of search effort. This effort included 97 separate mammal sightings of 13 different species/groups of species with an average of 1 sighting for every 12 nautical miles of survey effort. Table 4 summarizes these sightings and figures 3-4 display the locations of sightings.

During the April survey there was a greater number of sightings than in September 2008, particularly in the oceanic waters between the Ecuadorian mainland and Galápagos Islands coastlines. Common dolphins (*Delphinus delphis*) were the most frequently identified, though again,

identification of species was hindered by distance between the ship and mammals. Dolphin groups in all but a very few instances avoided the ship by actively swimming away from our cruise track and changing direction or traveling speed if necessary. Only a few bottlenose (*Tursiops truncatus*) and common dolphins attempted to bow ride.

TABLE 4. Apr 2-21 2009 Cruise Results.

Species	Number of Sightings
Blue Whale	1
Bryde's/Sei	2
Kogia sp.	1
Pilot Whale	4
Sperm Whale	3
Bottlenose Dolphin	4
Common Dolphin	6
Striped Dolphin	2
Galapagos Sea Lion	18
Unid Baleen Whale	2
Unid Small Whale	2
Unid Dolphin	48
Unid Odontocete	4

The first two groups of sperm whales sighted were actually just individuals, likely males. The third sperm whale group sighted was a mixed female group of approximately 9 individuals and which included 2 apparent juveniles or calves. The group was actively swimming and blowing at the surface, fairly spread apart but within visual distance of the ship and moving in the same direction as a group. After the group had passed the ship stern, 1 or 2 of the individuals were observed porpoising and leaping out of the water.

IV. CONCLUSION

The data from these cruises indicate that there are potentially large fluctuations in the population and distribution of marine mammals in Ecuadorian oceanic waters. These fluctuations may be due to seasonal intra-annual variations or inter-annual environmental variability. In the case of humpback whales, seasonal migration patterns have been well documented (Félix and Haase, 2005). Additionally, Letteval (1998) suggested that there are two peaks in the presence of sperm whale calves around the Galápagos Islands, one in June and another in February. These seasonal peaks do not coincide with the two juveniles/calves we observed in April 2009, however this was just one observations and research conducted by Hal Whitehead suggests that there has been a significant decline in the population of sperm whales since the publication of Letteval's thesis, particularly following the 1997-1998 El Niño.

The range of different species positively identified as well as the large proportion of sightings that could not be identified to species using current survey methodologies, suggests that the diversity and overall marine mammal abundance within Ecuadorian waters may be much higher than previously suspected. More surveys will need to be completed to determine reliable population estimates. Oceanographic cruises aboard the *Orion* provide an excellent platform for regular marine mammal surveys to aid management and

conservation efforts. Supplemental surveys aboard smaller vessels near the Galápagos Islands and mainland coast would improve our understanding of the dynamics and behavior within mammal populations inhabiting these waters.

Overall, these two cruises successfully mapped a general distribution for the present community of marine mammals in Ecuadorian waters and highlighted areas where further research is needed. Twelve different genus or species of marine mammals were identified including one group of sperm whales that included calves, one group of orcas that were likely feeding at the time of observation and one observation of the endangered blue whale. Our data are further evidence of the importance of the Ecuadorian marine environment to marine mammals. The next step is to compile a time series of remotely sensed oceanographic data in order to assess mesoscale spatial and short timescale environmental features important to each species and that may structure their distribution in this region.

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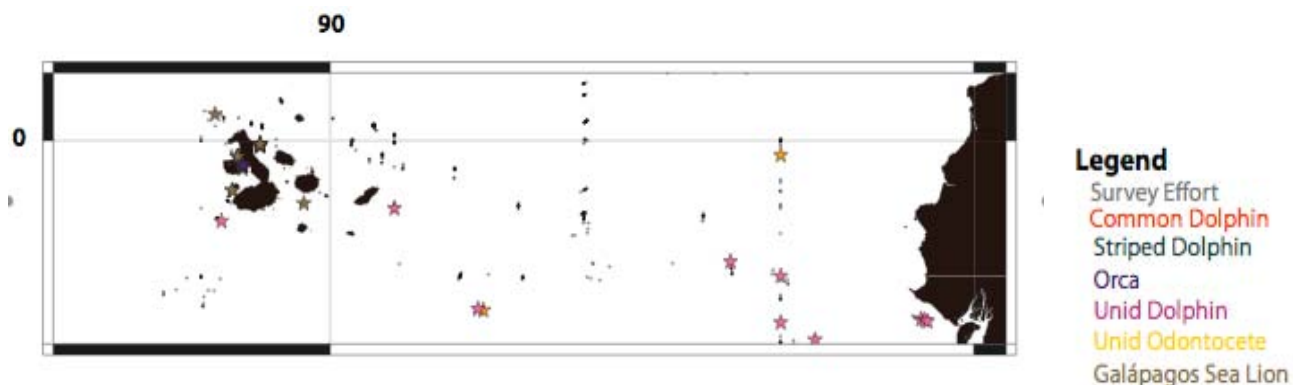


Figure 1. CO-01-08 September 2008 Marine Mammal Survey: Dolphin and Sea Lion Sightings

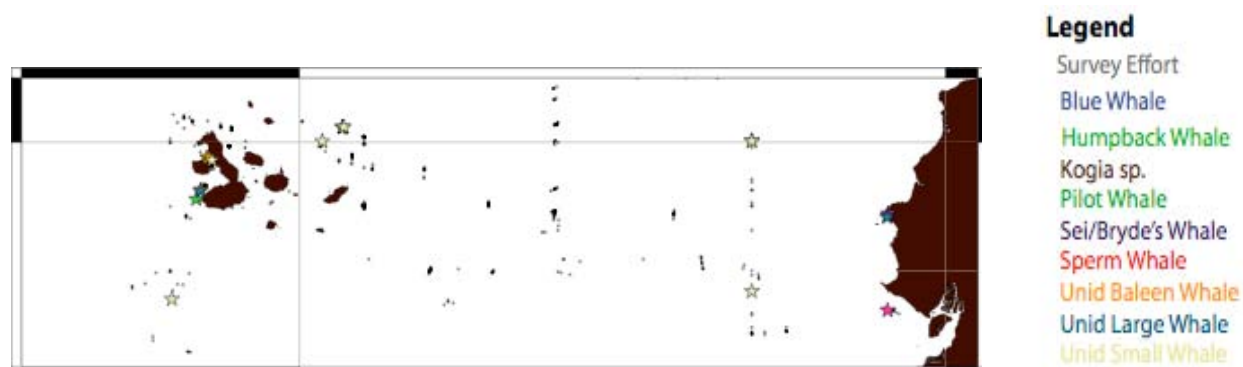


Fig. 2. CO-01-08 September 2008 Marine Mammal Survey: Whale Sightings

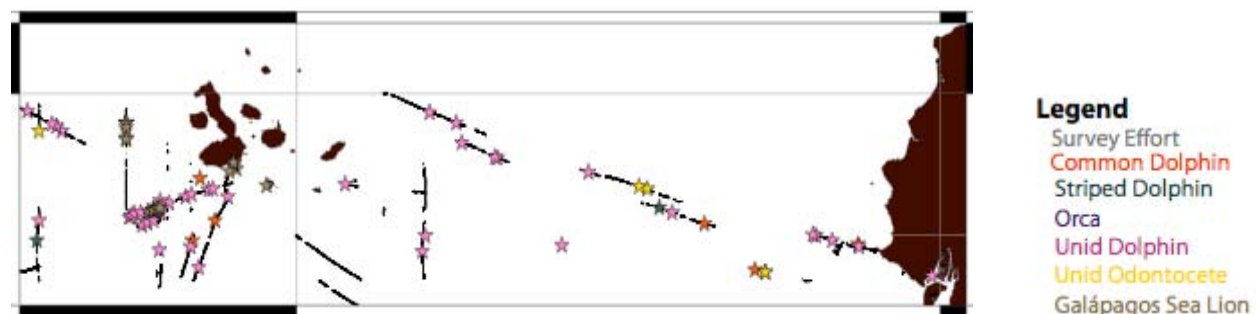


Figure 3. CO-01-09 April 2009 Marine Mammal Survey: Dolphin and Sea Lion Sightings

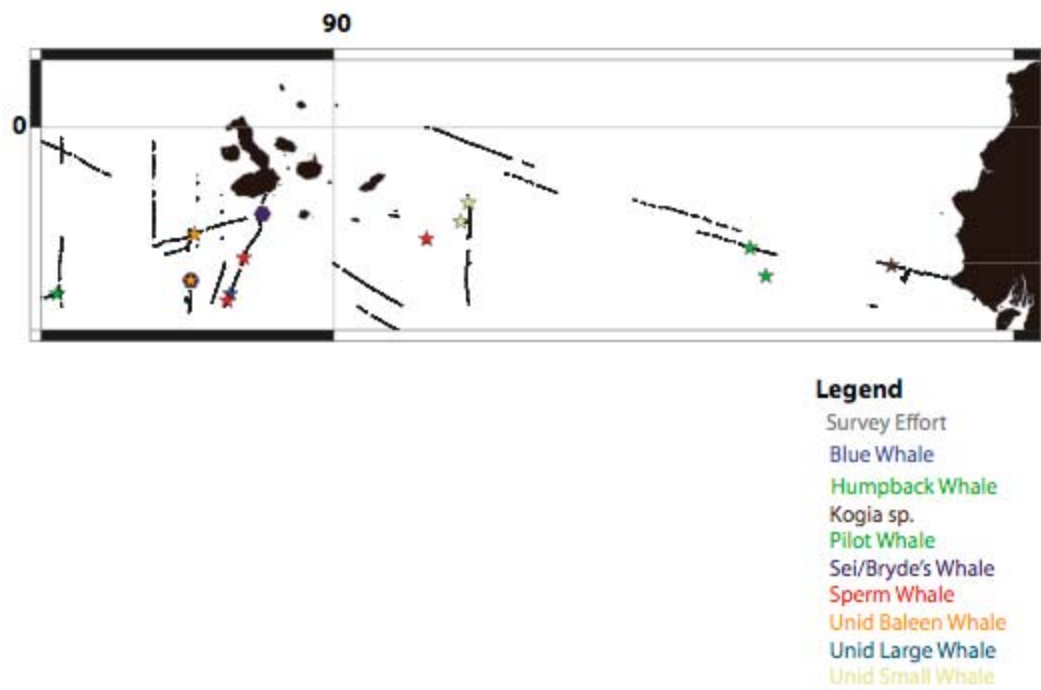


Figure 4. CO-01-09 April2009 Marine Mammal Survey: Whale Sightings